Premaxillary Deficiency: Techniques in Augmentation and Reconstruction

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Abstract

Progressive premaxillary retrusion is a common sequela of the facial aging process. In most cases, this manifests with central maxillary recession. Central maxillary insufficiency is also commonly encountered within certain ethnic communities, or in cleft lip nasal deformity, and may represent a challenge for the plastic and reconstructive surgeon attempting correction in the setting of facial contouring, rhinoplasty, or reconstruction following oncologic resection or trauma. Aesthetically, premaxillary retrusion may be coincident with an acute nasolabial angle and ptotic nasal tip. Minor deformities may be addressed with use of either alloplastic implants, autogenous tissue, lipotransfer, or injectable filler. Larger composite defects may require reconstruction with implementation of free tissue transfer. Herein, we describe techniques that aim to augment, or reconstruct, the premaxillary region in the context of nasal deformity, osseous resorption, or composite maxillofacial defects.

Keywords

- premaxillary retrusion
- injectable rhinoplasty
- augmentation rhinoplasty
- premaxillary reconstruction
- free tissue transfer

Insufficient projection of the premaxilla is a common deformity in a particular subcategory of patients, either with nasal cleft deformity or in patients of Asian or African American descent. Retrusion of this central maxillary segment may present with resultant distortion of the columella, nasal tip, or labial facial subunits. Anatomically, the premaxilla consists of the osseous segment between the two maxillary incisor fissures.[1] Hypoplasia of this bony segment results in significantly decreased premaxillary projection. Although characteristically observed in patients with cleft lip and palate deformities, this deformity may be seen in otherwise healthy individuals within Asian or African American communities.[2] The lack of underlying structural support results in retraction of the nasal base at the columella resulting in an acute nasolabial angle, relatively elongated upper cutaneous lip, tip ptosis, and labial incompetence.[1,3] Patients may present with isolated premaxillary deficiency seeking aesthetic refinement of these deformities. The reconstructive surgeon must, however, appropriately identify patients with concomitant findings indicative of malocclusion. Individuals with class III occlusion, in which the mandibular first molar is located anteriorly in relation to the mesiobuccal cusp of the maxillary first molar, will require orthognathic intervention.[1,4] In patients without malocclusion, and with adequate bone stock, premaxillary augmentation is the mainstay of treatment. A multitude of techniques have been described within the primary literature describing correction of the acute nasolabial angle and underlying premaxillary retrusion. Herein, augmentation techniques are described in settings of premaxillary hypoplasia, osseous deficiency of the maxilla, cleft lip nasal deformity, maxillonasal dysplasia, and free tissue transfer in cases with composite defects.

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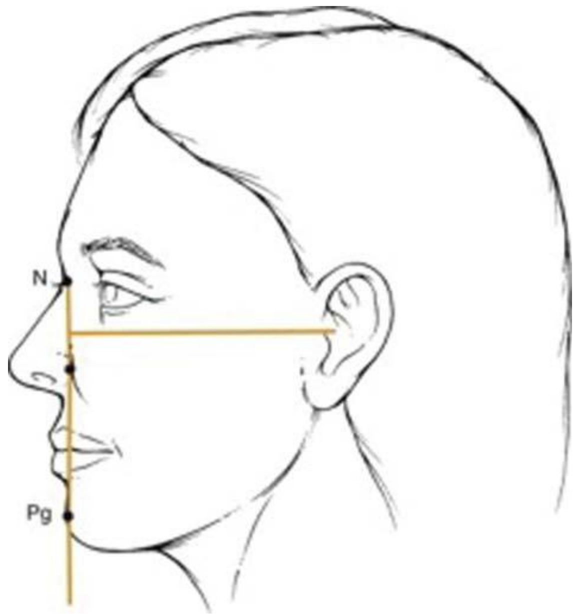

Fig. 1 Zero meridian method of Gonzalez-Ulloa[6]: Ideal chin position along a line extending perpendicular to Frankfurt horizontal through nasion (N) to pogonion (Pg). (Reproduced with permission from Flint et al.[59]

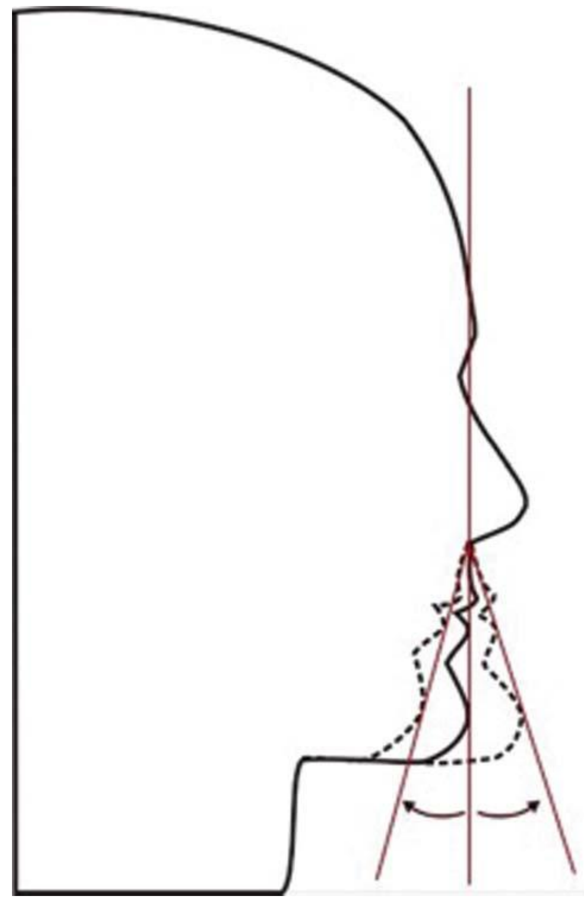

Fig. 2 Facial convexity angle[7]—Line extending from glabella through subnasale to pogonion; ideal angle of convergence is -12 ± 4 degrees. (Reproduced with permission from Naini et al.[8])

Preoperative Evaluation

A thorough examination of any patient planned to undergo premaxillary augmentation should be performed prior to intervention. Standardized photodocumentation of the patient should be taken for preoperative planning.[5] Proper balance and harmony between the upper and lower third of the face may be determined through analysis of the zero meridian line, as described by Gonzalez-Ulloa[6] (►**Fig. 1**). A line, perpendicular to the Frankfurt horizontal line, is drawn through the nasion and pogonion. Patients with adequate anterior chin projection will have their chin approach this line. After ascertaining the appropriate chin projection, the clinician should evaluate the middle third of the face by the angle of facial convexity (►**Fig. 2**).[7,8] With recession of the premaxilla—and correspondingly the overlying soft-tissue subnasale—from the anterior plane, the angle of facial convexity will approach zero and with extensive recession becomes positive. The degree of divergence from this ideal profile corresponds to the severity of recession.[1] In this regard, the intended outcome following premaxillary augmentation is reduction of the facial convexity angle toward zero or the ideal angle (-12 ± 4 degrees).[1,7,8] The amount of augmentation needed to achieve this has been described to correspond to approximately double the anterior soft tissue movement required, with a 0.5:1 soft-to-hard tissue ratio cited in maxillary advancement.[1,9,10]

Augmentation Techniques—Grafting

Several techniques have been described to address premaxillary recession, particularly in the setting of rhinoplasty, in patients presenting with satisfactory occlusion. Initial techniques involved wide undermining of the upper lip and nasal base or suturing of the orbicular oris muscle so as to increase soft tissue bulk within this area. However, these techniques often resulted in failure either due to puckering deformity or graft loss. To address these shortcomings, isolated treatment of a receded nasolabial angle was initially described by Cinelli with utilization of native caudal septal rotation flaps.[11] In this technique, an endonasal approach using intercartilaginous and transfixion incisions was used to gain access to the anterocaudal septum. These segments of native septum were then rotated at their point of attachment in a downward vector and sutured in place to augment the upper lip.[1,11] Laminated cartilage grafts placed anterior to the nasal spine have also been described. However, due to their small size these grafts were found to provide limited augmentation.[12] Autogenous bone, harvested from either the ileum or tibia, has also been described as a grafting material used in a similar manner to improve premaxillary retraction. This technique was initially combined with implantation of a carved Silastic (Dow Corning Corporation) implant, which extended the length of the alar base, to address the deficiency along this area.[13] Sculpted Proplast (Vitek, Inc.), Teflon (Vitek, Inc.) fluorocarbon polymer interdigitated with carbon fiber implants have also been implemented in augmentation techniques. However, these implants do very little in addressing the loss of premaxillary height, instead providing midline reinforcement of the upper lip in an anteroposterior dimension.[14] In addition to inadequate enhancement of premaxillary height, these techniques are limited in that they lack lateral projection, only supplementing the central component of the nasolabial region.

Technique

Several techniques in premaxillary augmentation have been described implementing either external rhinoplasty, endonasal, or transoral approaches.[1,13–16] Although external approach rhinoplasty provides excellent exposure, in cases of isolated correction of the premaxillary complex a minimalistic approach may be employed through either intranasal or sublabial dissection. With use of an intranasal approach, a 1.5- to 2-cm incision is placed along the vestibular floor. The incision is designed along the membranous anterocaudal septum and extended inferiorly along the floor of the nasal vestibule, at which' point the incision may be carried to the deep surface of the nasal spine. A periosteal elevator may then be used to elevate the periosteum developing tunnels along the alar bases bilaterally and extending a few millimeters laterally past the ala. An implant of the surgeons' choosing, either autogenous, homologous, or alloplastic, may then be implanted within this pocket. The pocket and incisions are subsequently closed with sutures. When implementing a sublabial approach, a vertical midline incision is designed along the superior gingivobuccal sulcus and a similar technique of periosteal elevation is then used to create a tract for graft insertion as previously stated.

Variations of premaxillary grafts have been described including customized "bat-shaped" Silastic implants.[15,16] The central component of these implants is designed with greater thickness in comparison to the lateral arms, which are thinner and tapered. This central area also has the greatest vertical dimension, which does not exceed 6 to 7 mm, to provide discrete yet subtle extension along the columellar base. The maxillary (posterior) aspect of the implant is designed with a notable cleft which fits onto the nasal spine facilitating stabilization (►**Figs. 3** and **4**).[15,16] If a periosteal tunnel is not created for implant placement, suture fixation to underlying periosteum or native cartilage may be necessary utilizing polydioxanone suture.

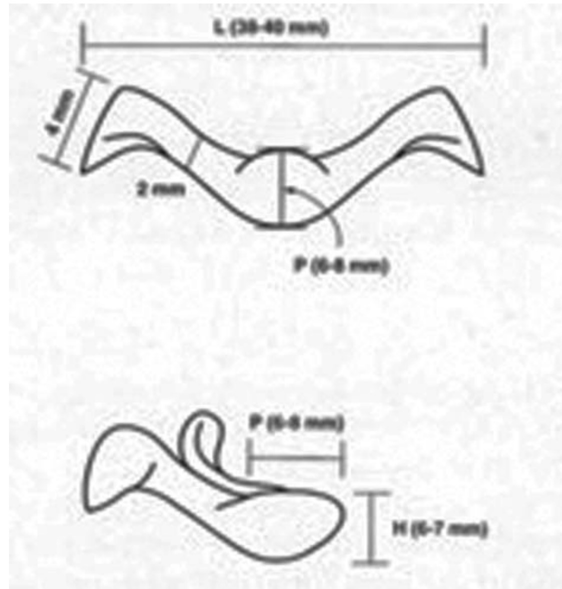

Fig. 4 Depiction of V- or "bat"-shaped Silastic implant. (Reproduced with permission from Fanous et al.[15,16])

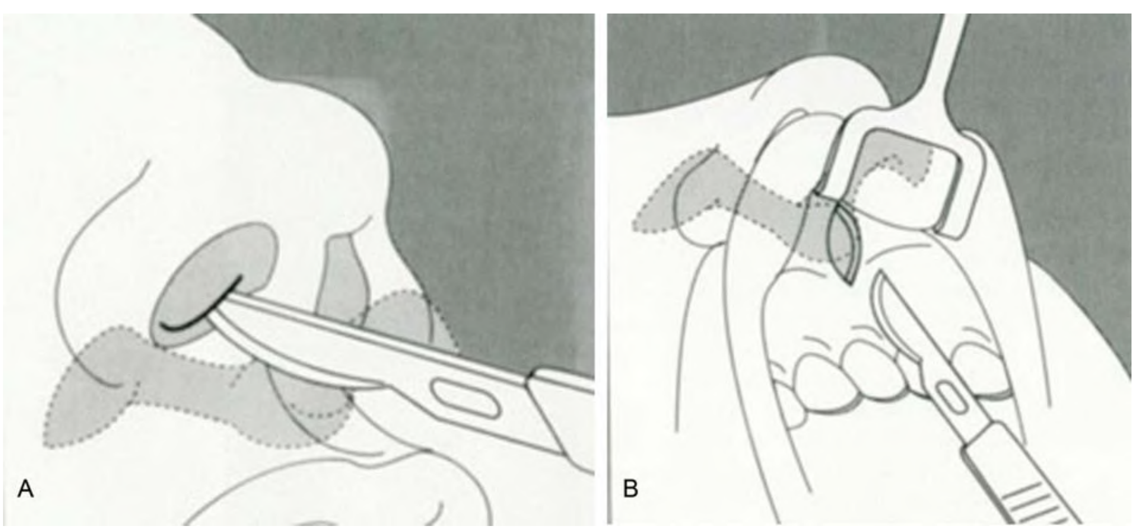

Fig. 3 (A) Intranasal approach to premaxillary augmentation. (B) Intraoral approach; Dotted lines and shaded segment correlate to bat shaped custom Silastic implant. (Reproduced with permission from Fanous et al.[16])

Implant Material

A multitude of implant types have been described for maxillary augmentation using Proplast, Silastic, Mersilene mesh (Ethicon US, LLC.), lipoimplants, autologous cartilage, or osseous segments fashioned from autologous mandible.[1,15–20] Reported complications using the previously noted implants include extrusion, displacement, infection, wound dehiscence, and decreased upper lip mobility. However, there is currently a paucity of data allowing for comparative analysis of implants within the premaxillary complex. Evidence may be extrapolated from studies regarding grafting material used elsewhere, during rhinoplasty. An ideal grafting material is biologically inert, resistant to infection, noncarcinogenic, retains physical dimensions over time, cost-effective, and easily removable.[21–24] However, no graft material meets all criteria comprehensively. Autologous grafts have become the benchmark against which all other graft material is compared and have shown the greatest stability and long-term results.[21–24] Autologous tissue displays inherent stability and biomechanical characteristics that are similar to the native structural nasal framework. Homologous, in particular irradiated rib cartilage, and alloplastic materials have gained popularity due to their availability and lack of donor site morbidity, but evidence suggests that they may confer additional risk of extrusion, infection, or warping and have dissimilar structural properties when compared with native framework. Costal cartilage is an attractive material for augmenting the premaxillary region due to the significant amount of material available at this site and its relative structural volume and rigidity when compared with septal or auricular cartilage. The most common complication associated with costal cartilage grafting is warping. Diced or crushed cartilage grafting may additionally be used depending on the degree of augmentation required. Cadaveric irradiated cartilage represents an alternative to autologous rib without conferring donor site morbidity. The risk of resorption reported is variable as this graft undergoes fibrovascular ingrowth overtime and has been shown to ultimately be replaced with connective tissue deposition.[22,24] While silicone represents an alluring option, complication rates vary significantly depending on the technique, surgeon experience, implant size, and location. The most commonly reported complications with use of this material include displacement and extrusion. These outcomes have been attributed to the lack of fibrovascular ingrowth and resultant micromotion with induction of a chronic inflammatory result and capsule formation.[24] Extrusion rates have ranged from 0 to 0.5% for augmentation rhinoplasty to as high as 10% in dorsal implants and even approach 50% in columellar implantation. External pressure along the overlying soft-tissue envelope, either due to inadequate soft-tissue coverage or excessively bulky implant size, is thought to contribute to the risk of extrusion along the tip-columellar complex.[24] A comprehensive overview of grafting material is beyond the scope of this article. Readers are referred to references for detailed review of available grafts and nasal implants.[21–24]

Nonsurgical Augmentation—Injectables

The use of injectable fillers has gained considerable popularity within the last decade.[25] The increased use, and corresponding experience of physicians, has resulted in the utilization of fillers for continually evolving indications.[26–28] The use of injectable filler such as hyaluronic acid, calcium hydroxyapatite, autologous fat, or collagen have become increasingly used in correction of premaxillary deficiency.

All injectables, particularly within the nasal region, carry the risk of intravascular injection. The nasal blood supply has robust anastomoses with major vessels including branches of the internal carotid. Injection technique is therefore of paramount importance to prevent vascular compromise. The majority of blood vessels surrounding the nasal soft tissue are within the superficial musculoaponeurotic system or in the superficial adipose layer.[29,30] Therefore, injection within the deep adipose tissue, directly overlying the maxilla, mitigates vascular compromise, preventing embolization. In addressing premaxillary deficiency with filler, a 29-gauge needle should be introduced medially, at the junction of the ala and upper cutaneous lip, to prevent potential injury to the lateral and marginal nasal arteries which are located more laterally. The needle should then be advanced to the level of the maxillary periosteum at which point aspiration is advisable, prior to injection, to confirm that instillation of filler is not performed intravascularly. The amount of filler needed will be contingent on the degree of premaxillary deficiency. During injection, one should be vigilant for signs of either extravascular or intravascular mechanisms potentiating the risk of vascular compromise such as dermal blanching, severe pain, or edema erythema and necrosis limited to a vascular territory.[31] Intra-arterial injection may result in retrograde emboli to the ophthalmic and retinal arteries with resultant ocular compromise and blindness. Early recognition of these symptoms with preventative intervention, utilizing high-dose hyaluronidase, is critical.[31,32] Visual complaints may indicate retrograde embolism within the retinal artery and potential central retinal artery occlusion. This represents an irreversible cause of blindness which may occur within 90 minutes. Emergent application of ocular massage, topical timolol 0.5%, sublingual nitroglycerin, followed by urgent referral to ophthalmology for possible retrobulbar application of hyaluronidase is recommended.[32,33] Injectable fillers, when applied with appropriate precaution and technique, generally display an acceptable safety profile. However, as previously mentioned serious side effects are reported throughout the literature. It is therefore necessary for the surgeon to have a working knowledge of the available filler products and proficiency in their respective characteristics. Injection of dermal filler in the patient with prior rhinoplasty or facial trauma must be performed with care to avoid intravascular injection, or pressure-induced ischemia, secondary to potentially altered nasal blood supply.

The ideal filler material should have long-standing results, appropriate safety profile, be easily injectable, and display minimal tissue reaction with limited migration. A detailed overview of injectables used in the nose can be found throughout the references.[31,34,35]

In addition to augmentation techniques employing injectable filler, autologous fat transfer represents a viable and attractive technique. Fat harvest is performed from a readily camouflaged highly lipogenic donor site, such as the abdomen or thighs, using a small 3- to 4-mm blunt suction cannula and 10-mL syringe. Injection constitutes similar techniques as implemented in dermal filler.[20,36] Lipoinjection has similar adverse effects with regard to intravascular injection, with added possible donor site morbidity. Additionally, variable graft resorption has been reported. However, patient satisfaction rates approach 80% with this technique.[36]

Free Tissue Transfer for Composite Defects

In the setting of trauma or oncologic ablation, maxillofacial defects involving the premaxilla represent a considerable reconstructive challenge due to the aesthetic and structural complexity of this region. Often composite defects may require free tissue transfer to address both underlying osseous structural and soft tissue components. Microvascular options include fibula, scapula, iliac crest, or osteocutaneous radial forearm due to their compositional characteristics. There are inherent reconstructive difficulties within the premaxillary region secondary to its structural role as scaffolding for the incisive dentition and the frontal nasal spine which provides support for the nasal pyramid.[37] The use of osteocutaneous free flaps facilitates the reconstitution of the nasal pyramid, midface projection, oral–nasal diaphragm, and establishes a platform for osseointegrated dental implants.[38,39] Several variants of osteocutaneous radial forearm,[40] iliac crest,[41] scapular ,[42] and fibular flap[38] have been described in the reconstruction of the premaxilla. While the radial forearm flap provides tissue pliability with added pedicle length, there is insufficient bone stock to support osseointegrated implantation.[40,43] The scapular free flap, initially popularized by Swartz et al,[42] has been extensively used in reconstruction of the central face.[40] The lateral osseous segment of the scapula may be oriented horizontally to reconstruct the alveolar process and contains sufficient corticocancellous bone to allow for dental implants. Vinzenz et al describe implementation of a prelaminated scapular flap using split-thickness skin graft, with prefabricated endosteal implants, in reconstruction of the premaxillary region.[44,45] A composite latissimus dorsi scapular free flap, based on the subscapular system, may be used if extensive soft tissue reconstruction is required.[46,47] However, the scapular flap has two main disadvantages. If the defect is isolated to the premaxilla, the bulkiness of a composite flap may be excessive. Conversely, if the scapular flap is employed as an osteocutaneous flap, the length of the pedicle is often too short to reach recipient vessels, necessitating use of vein grafts.

The iliac crest free flap, as described by Taylor et al[48] and Sanders and Mayou,[49] has demonstrated considerable utility in midface reconstruction when used as either an osseous, osteocutaneous, or osteomyocutaneous composition. The versatility of the iliac crest free flap facilitates transfer of significant bone stock, considerable soft tissue when raised with the internal oblique, and a sizeable skin island (20×15 cm). The primary limitation with implementation of this flap in reconstruction of the premaxillary region is the short length of the vascular pedicle, measuring 5 to 7 cm. Modifications, implementing a posterior osteotomy, have been described to harvest a pedicle of greater length. However, this prolongs operating times and often necessitates use of vein grafts, which itself increases risk of postoperative vascular compromise.[50–52] Furthermore, significant donor site morbidity should be considered when considering use of the iliac crest free flap including pain, bone contour irregularity, dysesthesia secondary to damage to the lateral femoral cutaneous nerve, deficits in ambulation, and abdominal hernia.[53–55]

The fibular free flap, in comparison, offers several characteristics that streamline premaxillary reconstruction (►Fig. 5). The fibular flap may be harvested as an osseous, osteocutaneous, or osteomyocutaneous allowing for reconstruction of a variety of potential defects. The segment of bone is linear, measuring approximately 22 to 25 cm in length, and may be osteotomized into multiple segments. This allows for recreation of the three-dimensional curvature of the premaxillary region. Furthermore, the small width, 10 to 15 mm, of the compact lamellar bone provides for significant structural integrity while reducing excessive volume that may potentially cause nasal obstruction or cosmetic deformity. The osseous strength of individual segments, 8 to 10 mm in length, allows for simultaneous insertion of osseointegrated dental implants.[56] The length, up to 12 cm when the distal bone segment is harvested, and caliber of the vascular pedicle permit microvascular anastomosis to recipient vessels without use of an interposing vein graft. Additionally, the fibula may be harvested with a considerable skin island and muscular cuff (flexor hallucis longus and peroneus longus) in cases with

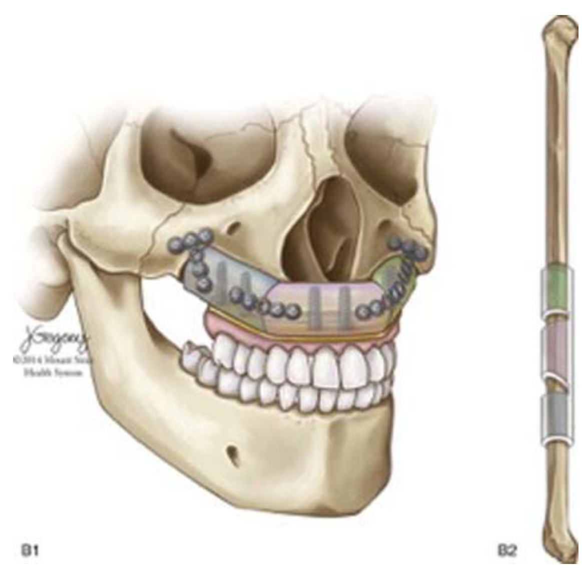

Fig. 5 Depiction of defect involving premaxilla reconstructed with fibula and implants using computer aided planning and guides. (Reproduced with permission from Okay DJ, Buchbinder D.[58])

significant composite deficits. Periosteal osteogenesis following reconstruction of the upper maxilla, with resultant trismus, has been reported with use of fibular flap for maxillary reconstruction. This poses a potential shortcoming, but may be addressed with delayed excision, 4 to 6 months following primary surgery, of ectopic bony formation. This has shown to be sufficient in allowing for angiogenesis and development of an independent osseous blood supply.[57] With the above in mind, fibular free flap reconstruction of the premaxillary region should be an initial consideration in the surgeon's armamentarium.

Conclusion

The premaxillary region has considerable aesthetic and functional significance within the midface. Reconstructive or aesthetic interventions within this region therefore present the plastic and reconstructive surgeon with inherent difficulties. Central maxillary insufficiency may be addressed with careful preoperative planning and implementation of several augmentation techniques utilizing either autologous or alloplastic grafting material. Additionally, injectable implants represent a continually evolving treatment modality in appropriate patients. Reconstruction of the premaxilla poses a unique dilemma. Free tissue transfer employed in this area must address the compositional nature of the anticipated defect while also considering the structural complexity of the maxilla and the need for osseointegrated dental implantation.

Conflicts of Interest
None declared.

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